

The Kaziranga Wild Life Sanctuary, Assam

BY

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(With two plates and two maps)

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I. INTRODUCTION

Kaziranga is renowned as one of the finest wild life sanctuaries in southern Asia. Although it is particularly noted for harbouring large numbers of Great Indian One-horned Rhinoceros (*Rhinoceros unicornis*), the other large mammals found here also deserve attention. In addition to rhino, wild buffalo, hog deer, swamp deer, and wild pig are almost invariably seen by visitors. It is practically guaranteed that visitors will see both rhino and hog deer, as well as swamp deer during certain seasons of the year. Indian elephant, gaur or Indian 'bison', sambar, barking deer, tiger, leopard, two or possibly three species of bear, and numerous smaller mammals are also represented. A list of some of the animals found in the sanctuary and their local and scientific names is presented in Table 1. Numerous birds, including red junglefowl, partridge, various doves and many species of water birds, are also common to the sanctuary. A nesting colony of spottedbilled pelicans (*Pelecanus phillippensis*) was first discovered inside the sanctuary in 1958. This is one of India's few pelicanries and the only one known in the northern part of the country.

The Kaziranga Sanctuary officially includes 165.84 sq. miles. However, due to erosion by the Brahmaputra River, the curve of which forms the northern boundary, the present size is probably less than 150 sq. miles. Most of the southern boundary is formed by the Mora (dead) Diphlu River, which roughly parallels National Highway No. 37, better known as the Grand Trunk Road of Assam. The eastern boundary is formed by both stream beds and surveyed lines. The shape of the

TABLE 1
NAMES OF SOME ANIMALS INHABITING THE KAZIRANGA WILD LIFE SANCTUARY, ASSAM, AND POSSIBILITIES OF VISITORS SEEING THEM

English	Local	Scientific	Remarks
Great Indian One-horned Rhinoceros	Gorh or Garh	<i>Rhinoceros unicornis</i>	Common
Indian Elephant	Hati	<i>Elephas maximus</i>	Frequent
Wild Buffalo	Bonoria Mah	<i>Bubalus bubalis</i>	Common
Gaur or Indian 'Bison'	Methun or Mathoon	<i>Bos gaurus</i>	Rare
Swamp Deer	Dol Horina : Male Batina-Sakal Jati ; Female Belingi	<i>Cervus duvauceli</i>	Common
Sambar	Sar or Katkhowa Pahu	<i>Cervus unicolor</i>	Frequent
Hog Deer	Khatia or Chagli Pahu	<i>Axis porcinus</i>	Common
Barking Deer or Indian Muntjac	Hugari or Sugari Pahu	<i>Muntiacus muntjak</i>	Infrequent
Indian Wild Boar	Borah or Bonaria Gahori	<i>Sus scrofa</i>	Frequent
Pangolin	Bon Rou	<i>Manis</i> sp.	Rare
Porcupine	Ketala Pahu or Palm	<i>Hystrix</i> sp.	Rare
Squirrel	Kerketua		Infrequent
Gangetic Dolphin	Seho, Hiho, Huh	<i>Platanista gangetica</i>	Rare
Tiger	Dhakiapatia Bagh or Bagh	<i>Panthera tigris</i>	Infrequent
Leopard or Panther	Naharphutuki Bagh	<i>Panthera pardus</i>	Rare
Jungle Cat	Bonoria Mekuri	<i>Felis chaus</i>	Rare
Large Indian Civet	Hepa	<i>Viverra zibetha</i>	Rare
Indian Wild Dog or Dhole	Rang kukur	<i>Canis alpinus</i>	Very rare
Jackal	Sial	<i>Canis aureus</i>	Infrequent
Common Mongoose	Neul	<i>Herpestes edwardsi</i>	Common
Common Otter	Ood	<i>Lutra lutra</i>	Rare
Hog-Badger	Joiga Borah	<i>Arctonyx collaris</i>	Infrequent
Himalayan Black Bear	Rola Bhaluk, Satum, Sitam, Mapol, Mansu, Bhurma	<i>Selenarctos thibetanus</i>	Rare
Sloth Bear	Mati Bhaluk		Infrequent
Rhesus Macaque	Nilaji Bandar	<i>Melursus ursinus</i>	Infrequent
Common Langur or Hanuman Monkey	Hanuman Bandar	<i>Macaca mulatta</i>	Frequent (Baguri Block)
Hoolock or Whitebrowed Gibbon	Holou Bandar	<i>Presbytis entellus</i>	Frequent (near Bara-Porhar)
Water Monitor	Pani Guin	<i>Hylobates hoolock</i>	Infrequent (near Bara-porhar)
Indian Python	Ajagar	<i>Varanus salvator</i>	Infrequent
Common Cobra	Feti Sap	<i>Python molurus</i>	Infrequent
King Cobra	Chakori Feti Sap	<i>Naja naja</i>	Rare
		<i>Naja hamnah</i>	Rare

KEY.—Common = almost invariably seen ; Frequent = generally seen ; Infrequent = only occasionally seen ; Rare = rarely seen.
This is only a relative index as to the possibilities of a visitor observing animals and does not always infer the relative abundance of the species in the sanctuary.

sanctuary is more or less an oval, which is approximately 25 miles long and 8 miles wide at the widest point (Map 1). The nearest airport is Jorhat, 60 miles to the east. Gauhati is 135 miles to the west. There is a well-constructed tourist lodge and a tourist bungalow at Kohora, which is about mid-way along the southern boundary of the sanctuary. Both are administered by the Tourist Department, which also provides catering service for visitors. The Forest Department has two forest rest houses—Baguri, located along the Grand Trunk Road near the western end of the sanctuary, and Arimora, which is in the heart of the sanctuary about 10 miles north of Kohora. Catering is not provided at these two places. Riding elephants are also provided for visitors by the Forest Department. The ease with which visitors may view rhino and other animals at close range from elephant back during a very short visit makes Kaziranga a unique experience. A Forest Range Officer stationed at Kohora is in charge of the sanctuary and supervises a staff of over 100 men. These patrol and protect the sanctuary and its wild life, maintain the sanctuary's roads, buildings and equipment, and care for the domestic riding elephants.

There were a number of reports during 1964 and 1965 concerning the slaughter of rhino by poachers inside the sanctuary. Although some of these reports were clearly exaggerated and others appeared to be unfounded, the Forest Department decided to conduct a full scale census to determine the exact status of the wild life and particularly of the rhino. Upon the suggestion of Mr. Gee, member of the Indian Board for Wild Life and a noted authority on the Great Indian One-horned Rhinoceros, Mr. P. Barua, Chief Conservator of Forests for Assam, solicited my assistance. I am grateful to both of these men for the opportunity to have participated in this census. I spent most of the time between March 2 and 17 on elephant-back inside the sanctuary, attempting to become acquainted with as much of the area as possible. The actual census was conducted on March 17 and 18 and the collected data was tabulated on the 19 and 20. I revisited the sanctuary between June 9 and 14. Observations were then made both from boat and elephant back as to the effects of the monsoon and flooding inside the sanctuary.

The nature of the vegetation and the terrain in Kaziranga thwart the use of most methods commonly used to determine wild life populations. Counting animals from an airplane was tried on 24 March 1949, but the grass cover was so dense that only a few animals could be counted. A six-seater airplane was used during this attempt and was not flown below a height of about 400 feet. Perhaps the use of a lighter airplane, which could be flown at lower altitudes, would provide a relatively accurate and inexpensive means of counting most of the rhino in the sanctuary. This was further confirmed by a discussion

with a Capt. Tamang when I was visiting Nepal in April. Capt. Tamang is a pilot for the Royal Nepalese Airlines, but regularly flew over Kaziranga while he was in the Air Force. He stated that the wild animals were readily observed from the air and that he often sought out particular individuals.

A wild life survey of Kaziranga was conducted with 11 elephants on 19 April 1963. The sanctuary was divided into seven blocks and from one to four elephants were used to count the wild animals in each block. However, it was found that the areas were much too large to be effectively covered in a single day by the number of elephants employed. Only a sample count was obtained. Therefore, this report covers the first extensive wild life census of the Kaziranga Wild Life Sanctuary.

II. HABITAT

The Kaziranga Wild Life Sanctuary lies in the Brahmaputra River flood plain. This riverain habitat consists primarily of tall, dense grasses interspersed with open forests, interconnecting streams, and numerous small lakes called 'bils' or 'bheels'. Much of the sanctuary is submerged by the annual flood waters of the Brahmaputra. However, the well-forested Mikir Hills, which rise to a maximum height of 4000 feet are located across the Grand Trunk Road to the south. These offer a ready retreat for many animals from the sanctuary during the flood season. The climate is monsoonal with rains usually from May to October. The average rainfall is approximately 80 inches per annum. The ground and grass become fairly dry by late November or early December and during February and March much of the grassland area is burned by the sanctuary staff.

Grassland

A transect taken from the Brahmaputra River inland indicates the vegetational succession of the area. *Kash* (*Saccharum spontaneum*), a thin wiry grass with a maximum height of about six feet, first invades the dry sandy-silt soils recently deposited by the river. *Jhau* (*Tamarix* sp.), an evergreen shrub resembling some ornamentals used in gardening, is often interspersed with *kash*. Depending upon the nature of the habitat, these are generally followed by other species of grass. The bamboo-like *nal* (*Arundo donax*) predominates in marshy areas near permanent water, while in somewhat drier, but still moist, areas it is *khagra* (*Phragmites karka*). Areas flooded during the rains, but later dry, are mostly covered by *ekra* (*Erianthus* spp.), which is the most common grass in the sanctuary. The slightly higher or drier areas are dominated by *kher* or thatch (*Imperata cylindrica*). Most of these grasses, often collectively called 'elephant grass', attain a height of 15 feet or more by late summer.

Animals literally tunnel through them and even a herd of elephant may pass near by in this grass jungle without being observed. Each year between one-third to one-half of the sanctuary's grasslands are burned. Many animals were observed to re-enter the burned areas almost immediately and appeared to relish the remaining mineral-rich ash. The new growth, which shoots up within a few weeks after burning, also attracts the wild animals and probably provides the most palatable forage. The lowlands surrounding the *bils* favour the andropogonous grasses. These are relatively short (less than three feet high) and provide the only open areas in the sanctuary during much of the year. These areas appear to be favoured by most of the ungulates and probably provide the best year-round grazing for much of the wild life.

Forests

Without annual burning the aforementioned grasses are eventually replaced by flood-resisting species of trees. The dominants are silk cotton or *simul* (*Bombax ceiba*, formerly known as *Bombax malabaricum*) and the leguminous *koroï* (*Albizia procera*). *Ajar* (*Lagerstroemia flos-reginae*) and *outenga* (*Dillenia indica*), as well as other species, are also present. There are scattered groups of trees on both ends of the sanctuary and denser stands along the banks of the major streams, such as the Diphlu River. The ridge-like banks of the larger streams are generally higher than the surrounding terrain. Some of the forests are relatively open, but others are a tangled mass of almost impenetrable undergrowth, much of which consists of thorny species such as cane or *tita bet* and *jati bet* (*Calamus* spp.). The dense undergrowth provides excellent cover for wild life, particularly for elephant and rhino. Dense stands of the broad-leaved *tara* (*Hedychium* sp.), which is greatly relished by elephant, are also frequently associated with the forested areas.

Fire and Flood

Annual burning of the grasslands along the Brahmaputra River valley has been practised for so many hundreds of years that it can probably be considered as an integral part of the ecology of this region. In fact, the grasslands are maintained by fire and without it many would eventually become forests. There are invariably a sufficient number of unburned areas to provide cover for the animals until re-growth takes place. In fact, it is practically impossible to burn an entire area clean. Without burning there might actually prove to be a lack of suitable forage during the late summer season. The only animals which were observed not to benefit from the burning were some of the early nesting birds and some of the slower-moving reptiles, such as the python, which are occasionally consumed by the roaring flames.

Annual flooding of the sanctuary by the Brahmaputra River is probably essential for the maintenance of optimum habitat for some

species, such as rhino and wild buffalo. However, it is also probably a limiting factor in so far as populations of other species, such as sambar and barking deer, are concerned. Almost all of the sanctuary's streams and *bils* have been invaded during recent years by water hyacinth (*Eichhornia crassipes*). Floods are presently the only means by which these water areas are temporarily cleared and without floods they would shortly become solid green masses of vegetation. Although the dry water hyacinth plants are burned in the ephemeral *bils*, it is not yet known if this is of any benefit in checking re-infestation by this undesirable weed. Overall flooding is probably beneficial, if not essential, for most species of mammals in the sanctuary. Besides temporarily clearing the water areas of water hyacinth, they replenish the water supply in the numerous *bils*, and essentially irrigate the savannah-like grasslands. The numerous fish of several species in the sanctuary's *bils* are also dispersed by the annual floods. This serves the useful purpose of re-stocking areas adjoining the sanctuary with valuable fish. Because of this and the fact that the sanctuary serves as a spawning ground the Forest Department has resisted attempts by local interests to exploit the sanctuary's fishery resources.

Between June 9 and 14, during the monsoon season, I visited the Baguri Block twice by boat. During the first visit we travelled about six miles up the Mora Diphlu from the western end of the sanctuary. Three rhinos were observed to be contentedly grazing along the bank in water approximately three feet deep. Other rhino were heard moving in the flooded grasslands, but we were unable to see them. A large herd of wild buffalo was also seen, but it was impossible to get a count as they sloshed through the flooded grass. During the second visit we crossed the block from south to north in the area behind the Baguri Forest Rest House. The water in most of the *bils* was over 12 feet deep and much of the grassland was under more than six feet of water. We briefly visited the high-forested area near the Diphlu River. Although we saw a female rhino with a calf here, relatively few tracks of other animals were seen. I estimated that almost 80% of the Baguri Block was under water. Forest Department personnel observed large numbers of wild elephant crossing the Grand Trunk Road into the Mikir Hills to the south on the first of June. Some animals, such as hog deer, were also known to have crossed the road. Rhino and wild buffalo appear to be little affected by flood waters under four feet deep, but it is not known where the vast majority of the wild animals in the sanctuary take refuge during the flood season.

Mihi Mukh was visited on elephant back on June 11. Swamp and hog deer appeared to be concentrated on the relatively dry grasslands near the edge of the sanctuary. However, nine of the sixteen rhino which we saw were in water about four feet deep. Several were feeding

on vegetation under the water and two were observed to swim distances of over 50 yards. A group of sixteen buffalo were also seen in an area flooded by about two feet of water.

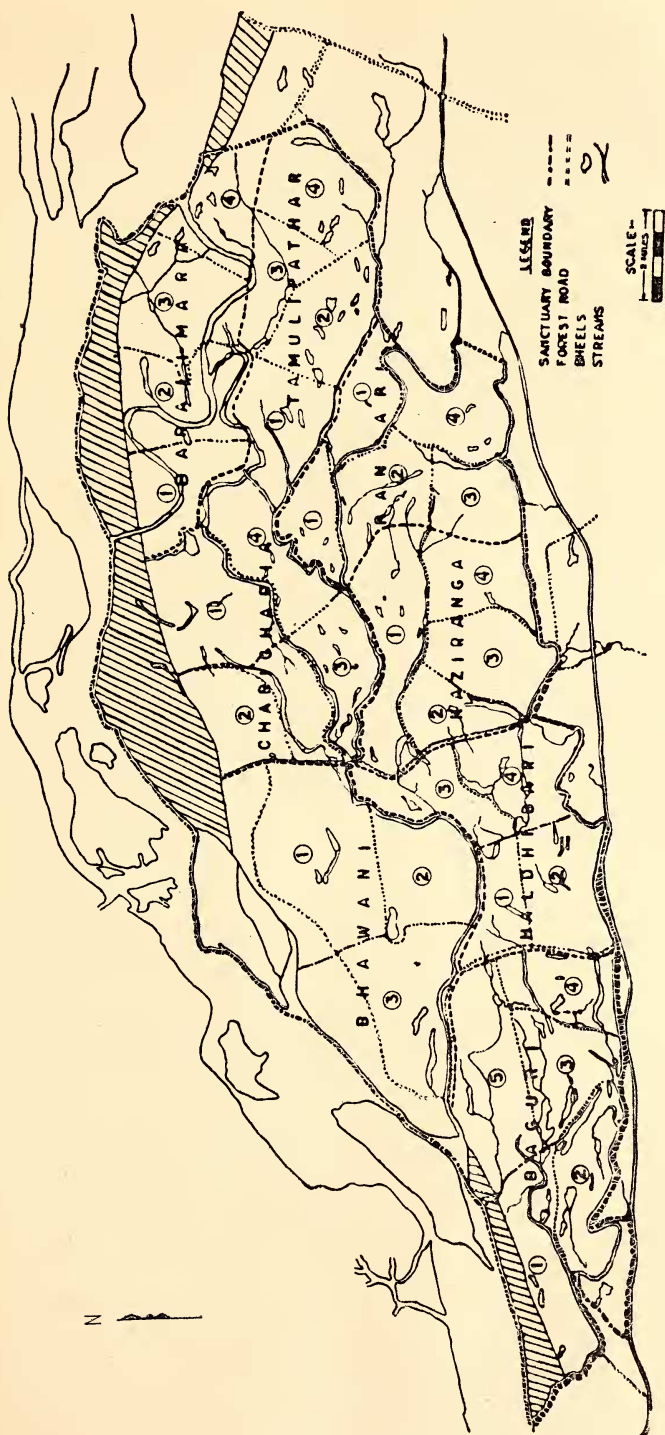
III. CENSUS METHODS

Prominent features, such as rivers or roads, were used to divide the sanctuary into eight blocks : Baguri, Haldhibari, Kaziranga, Panbari, Tamulipathar, Bhawani, Charigharia, and Baralimora. Each block was subdivided into three to five compartments including approximately five square miles each. There were a total of 33 compartments (Map. 2). Where it was not possible to use natural features, such as *bils* or streams, 10-foot wide compartment boundaries were cut through the vegetation by the sanctuary staff.

A total of 18 census parties consisting of an enumerator, helper, guide, mahout, and elephant were used to carry out the census. Both the enumerators and helpers were experienced Foresters, Deputy Rangers, or men acquainted with wild life. Guides were members of the sanctuary staff that had worked in and were acquainted with the particular area to which they were assigned. Ten mahouts and their elephants from the sanctuary were used during the two-day census operation. However, it was necessary to hire eight mahouts and elephants from outside.

Enumerators were in charge of their respective parties and recorded all the wild animals observed as to species and sex or age class (i.e. adult male, adult female, or young). Special forms were provided for recording this data. If there was any doubt as to the sex of an adult animal it was recorded as 'non-sexed'. Only the eight most common large mammals in the sanctuary were listed on the form. Other miscellaneous observations (animals fighting, mating, etc.) were recorded either in the miscellaneous or remarks columns. The helper was provided with a map of the block and compartment to which he was assigned. He plotted the approximate line of travel for the census party, the location of the animals observed by the use of abbreviated symbols (i.e. eight buffalo = 8 B), and the location and approximate area which had been burned within the compartment. The guide assisted the helper and ensured that the party remained inside its assigned compartment and did not trespass into others. The mahout directed the elephant and assisted the enumerator in identifying and determining the sex or age of the animals observed.

The enumerators and helpers were instructed and tested for two days prior to the census. During this time the guides inspected and became well acquainted with the assigned compartments. Each party camped the previous night at an assigned starting point prior to censusing the compartment the following day. Census operations were conducted



Map 2. Map of the Kaziranga Sanctuary, Assam, depicting the blocks and compartments used during the 1966 Wild Life Census

from 05:00 to 09:30 hours in the morning and from 14:00 to 17:00 hours in the afternoon. Sunrise was at approximately 05.30 and sunset at 17:00 hours.

A few compartments, which were relatively small or open areas, were covered in less than the assigned time. However, other compartments took longer than the assigned time. A total of 158 census hours were spent during the morning by the census parties and only 96 hours in the afternoon during the two-day census. The average census time per compartment was 7.7 hours. The four blocks south of the Diphlu River, namely Baguri, Haldhibari, Kaziranga, and Panbari, consisted of 18 compartments. These were censused the first day, March 17. The census parties then moved that evening to pre-arranged starting points in the four blocks north of the Diphlu River, namely Tamulipathar, Bhawani, Charigharia, and Baralimora, which consisted of 15 compartments. These were censused the following day, March 18.

After completion of the two-day census, all forms and maps were collected and the data individually reviewed with the enumerator or helper concerned to ensure that it was complete and free from errors. The overall census operation was well-planned and efficiently run. I feel that the data collected was reliable and subject to very little error. The methods used, however, give only a minimum count of the principal species of large mammals. A great deal of care and judgment, based upon experience and an intimate knowledge of the entire sanctuary, must be used to estimate the numbers of the different species that were overlooked or missed.

IV. RESULTS

A riding elephant in open country can cover between 3.5 and 4.0 miles per hour (mph). However, when forcing its way through dense grass or undergrowth it does well to cover 2.0 mph. Using a figure of 2.5 mph. for the average of 7.7 census hours per compartment, it can be assumed that approximately a 20-mile transect was covered in each compartment. The compartments averaged just under 5 sq. miles each and were probably slightly less than 2.5 miles per side. Each census party should have made about eight transects per compartment. Therefore, to cover completely the average compartment, each transect would have to cover a strip slightly less than one-fourth mile wide. The majority of the larger mammals could probably be observed in an even wider strip in open or burned areas, but in tall dense grass or undergrowth, visibility was limited to a few yards or even feet on either side of the elephant. Transects, however, were not run in regular lines. By use of the map provided, an attempt was made to cover those sites where animals were most likely to be seen, such as burned areas and the short grasslands

surrounding the *bils*. In short, each census party attempted to observe as many animals as possible during the allotted time, without duplication. When disturbed most of the animals moved into dense cover. This generally required a movement of less than 100 yards. Many animals, if not closely approached, did not even seek cover. Therefore, there was probably little, if any, duplication in the counts. After examining the maps and the approximate line of travel taken by each census party, I roughly estimated that less than 70% of the sanctuary was covered. However, it appeared that most of the preferred habitats were covered. Therefore, it can be assumed that much less than 30% of most of the larger mammals were missed. The numbers of animals tallied per compartment and the completed compartment maps, which indicated the burned areas, were compared with my previous observations for that area. I then made a conservative estimate of how many animals I felt may have been overlooked during the census. The actual census count as per block and my total estimates for the sanctuary are given in Table 2.

Age Composition and Sex Ratios

Age composition, although often difficult to determine accurately in the field, is generally a reflection of the status of a species in terms of its reproductive potential. A high percentage of young as compared to adults generally indicates a growing or thriving population. In contrast, a relatively small percentage of young usually indicates a low reproducing or senile group. Sex ratios likewise are an indication of reproductive potential. Most large mammals, particularly the ungulates or cud-chewers, are promiscuous about mating and can increase rapidly with five or even more females per adult male. Therefore, within limits of course, a population with more females than males generally has a higher reproductive potential than does one that is predominantly male. However, adult males are more spectacular and visitors to a sanctuary generally prefer to see them rather than females or immature animals. With reliable age composition and sex ratio data a biologist can often compute the average annual rate of net increase or loss, as well as determine the present status of a population.

Field glasses were not available for the census workers. Age composition data was, therefore, restricted to two categories (adult and young), which in most cases could be readily distinguished without the aid of binoculars. However, rather than bias the sex ratio data which was collected, whenever there was any doubt as to the sex of the adult animals observed, they were tallied in the 'non-sexed' column. No attempt was made to sex young animals or hog deer. The age composition and sex ratio data collected during the census are presented in Table 3. These, along with data which I collected, will be discussed later.

Wild life populations do *not* remain static. Increases or decreases often occur rapidly and a single census rarely provides answers to questions about several aspects of the population. An accurate census of the total wild life population is essential for the proper management of a sanctuary, but data should be collected and analyzed continuously in order that current conservation measures may meet the demands of changing situations. Therefore, it should be realized that the results of the 1966 wild life census of Kaziranga provides only a basis for future management. And an annual census of the wild life should be considered as a part of the sanctuary's management plans. An effort should also be made to determine the most economical means of conducting wild life surveys in Kaziranga, while still providing reliable results. For example, if the guides were thoroughly acquainted with their assigned compartments, there would be no need of going to the expense of cutting compartment lines. There is no reason why a census could not be conducted over a one or even two-week period. This would permit the use of only sanctuary elephants and experienced personnel and would result in less expense to the Forest Department, while providing more accurate data (i.e. information concerning sex ratios and age composition). As previously discussed, there is also the possibility that the use of airplanes would provide an economical, but satisfactory, means of conducting wild life censuses in Kaziranga.

Perhaps of interest, two carcasses of rhino, which had apparently died of natural causes, were found during the course of the census. The sale of the collected horns at public auction by the Forest Department should more than meet the total expenses incurred by the census operation.

Rhino

Rhino are relatively difficult to sex in the field, except in the case of females with young. Similar to many wild animals, when disturbed rhino frequently urinate. This enables a keen observer to sex individuals accurately. But, other than observing their private parts, there appears to be no fool-proof criterion for sexing solitary rhino. However, some claim to be able to differentiate the sexes by the size or shape of the horn and others maintain that the males have a thicker neck than the females. These criteria were not substantiated by my observations.

TABLE 3

SEX AND AGE CLASSIFICATION DATA FOR THE COMMON LARGE MAMMALS OBSERVED DURING THE 1966 WILD LIFE CENSUS OF THE KAZIRANGA WILD LIFE SANCTUARY, ASSAM

Species	Non-sexed	Number of Animals		Young	Total
		Adult Male	Adult Female		
Rhino ..	172	67	83	44	366
Wild Elephant	214	62	44	29	349
Wild Buffalo	115	54	217	85	471
Swamp Deer	141	17	49	6	213
Sambar ..	6	33	61	20	120
Hog Deer ..	1,033	105	119	54	1,311
Wild Pig ..	72	36	27	20	155

A total of 366 rhino were tallied during the two-day census. Three hundred and twenty-two or 88% were adults, of which 172 or 53% were 'non-sexed'. Eighty-three or 55% of the 150 sexed adults were females and 44 or 29% of these were accompanied by young. Admittedly, with such a high proportion of 'non-sexed' animals, the true sex ratio of the population cannot be ascertained. However, assuming a 50-50 sex ratio for the 322 adults observed, there was only one young for every 3.7 of the assumed adult females or only 27% were accompanied by young.

Dr. George Schaller observed a total of 48 adult rhino and five young in May 1965. Once more assuming a 50-50 sex ratio for the adults, he observed only one calf for every 4.8 of the assumed adult females or 21% were accompanied by young.

I personally observed 162 rhino between March 3 and 18 : 62 'non-sexed' adults, 21 adult males, 45 adult females, and 34 young. Sixty-eight % of the sexed adults were females and 34 or 76% were accompanied by young. Again assuming a 50-50 sex ratio for the 128 adults observed, there was one young for every 1.9 of the assumed adult females or 53% were accompanied by young.

Most of the rhino which I observed were in the Baguri Block, which has the highest rhino density and is the most productive block in the sanctuary. Almost 43% (157 of 366) of the adult rhino and over half (23 of 44) of the young tallied during the census were observed in this block. No rhino were reported in eight of the sanctuary's 33 compartments. Therefore, my sample may indicate a much higher young-female ratio than is true for most of the sanctuary. However, this is perhaps an indication of what the young-female ratio should be in a thriving or growing population. Perhaps this is an indication that the rhino population

Spillett : Kaziranga Sanctuary



Above : A herd of Wild Buffalo in Kaziranga. The master bull is in the rear. Below : Mother and young rhino in Kaziranga. The baby is leading the way as usual.

(Photos : E. P. Gee)

Spillett : Kaziranga Sanctuary



Above : A census party in Kaziranga crosses a *bil* covered with water hyacinth. *Below :* One of the cold weather jeepable roads inside Kaziranga

(Photos : J. Juan Spillett)

in many parts of Kaziranga has reached its peak. Nevertheless, the animals appear to be in good condition and with the high number present there is no reason why the Forest Department cannot begin to realize a financial return from the sale of some of its rhino resources. A few rhino could probably be sold to reputable zoos each year without any appreciable effect upon the sanctuary's rhino population.

I noted during my observations that almost invariably when a female rhino was accompanied by a calf, other females with calves could be located near by. For example, while visiting the Kaziranga Block on March 14, we observed five females within a radius of 200 yards, all of which were accompanied by young. In fact, even though these were in an open forest area intermingled with tall, dense grass, we were able to observe eight of the rhino (4 females and 4 young) at one time. There were also no *bils* or other features near by which could be considered as an attraction to these rhino. No young were reported from the Kaziranga Block during the census. Therefore, it appears that this entire group was probably missed by the census party in this compartment. On other occasions, up to 20 adult rhino would be tallied at a stretch, then within a relatively short time several females with calves would be observed, one pair right after another. This same phenomenon was later noted during studies in April in the Jaldapara Wild Life Sanctuary of West Bengal. Whether or not there is a definite social relationship among females with young deserves further investigation. There is, however, the possibility that 'pockets' of females with young were missed during the Kaziranga census and that the young-female ratio for the sanctuary was not as disproportionate as was recorded.

Rhino calves apparently remain with their mothers for almost four years, after which the female again breeds. The young attain puberty at about four-and-a-half years of age and the females have heat periods at intervals of 40 to 50 days. The gestation period, as observed with captive animals in the Whipsnade Zoo, is 488 days or approximately 16.3 months (Asdell 1964). Therefore, it appears that the maximum rate of increase in the wild state would probably be little more than one calf per female every five to six years. With such a slow rate of increase it would generally be assumed that the young-female ratio should perhaps approximate my figures.

The reason or reasons for the apparently low reproductive rate of much of Kaziranga's rhino population is not readily apparent. However, 366 rhino were counted during the two-day census, which was conducted when only about one-third of the sanctuary's grasslands had been burned. I am certain there are at least 400 rhino in the sanctuary. This means that over one-half of the Great Indian One-horned Rhinoceros in existence are located in the Kaziranga Wild Life Sanctuary !

Wild Elephant

Elephant are readily sexed in the field when they are clearly observed. However, the forests or dense habitat in which they are usually encountered in Kaziranga, their generally shy or retiring nature, and the fact that they are usually met in fairly large groups, make it difficult even for an experienced observer to record accurately sex and age composition data for groups encountered. The gradual increase in size from a new born calf to a mature elephant also makes it difficult to determine which animals should be classified as adults and which as young. This is particularly true when only two categories (adult and young) are used. Therefore, the sex and age ratio data collected for wild elephant during the census has little significance, but the total number counted does.

The tribal Mikirs were burning extensive areas for their *jhum* cultivations in the Mikir Hills south of the sanctuary prior to and at the time of the census. There were perhaps more elephant in the sanctuary due to this disturbance than would normally be expected. This was further indicated by numerous trails and recent elephant tracks entering the sanctuary through the south-west corner where the forest provides a natural passageway into the nearby hills. Elephant are migratory or nomadic and, except for some solitary males, rarely remain in the same vicinity for long periods of time. Also, they tend to move as a group or herd, which can generally be identified by its composition or by the presence of easily identified or 'marker' individuals.

A total of 349 elephant were tallied during the two-day census. Three herds totalling 241 or 69% of all the elephant censused were observed in compartment 1 of the Bhawani Block. Twenty of the sanctuary's 33 compartments reported no elephant and five reported only solitary males. Prior to the census I observed many fresh signs and frequently heard elephant nearby, but I saw only four solitary males. However, I tallied two elephants during the census and observed movements in the forest undergrowth where others remained hidden. It is certain that some elephant were missed. Therefore, there were probably at least 375 elephant in the sanctuary during the census, although many of these are probably not permanent residents. This is relatively high number for an area the size of Kaziranga and exceeds all previous estimates. Elephant may become too numerous in the sanctuary and eventually become a major problem. *Kheddas* and *mela shikar* conducted in the Mikir Hills south of the sanctuary would help to hold the number of wild elephant in check. This would result in no disturbance to the sanctuary and could also provide a source of revenue to the Forest Department.

Wild Buffalo

Buffalo are not difficult to sex in the field, although immature males may be quite easily mistaken for females. There may also be some

ambiguity as to whether a yearling or even a two-year-old should be classified as adult or young. With the exception of solitary males, buffalo are usually encountered in groups or herds. However, in contrast to herds of elephant which may contain a number of adult males, a herd of buffalo usually contains only one adult male and perhaps a number of immature males. Buffalo herds in Kaziranga are generally observed in or around the *bils*, particularly during the warmer part of the day when they come to lie or wallow in the water and mud. Buffalo in some areas regularly visited by tourists have become accustomed to the presence of man. But in most parts of the sanctuary they are wary and generally seek cover and remain hidden whenever man appears on the scene.

A total of 471 buffalo were tallied during the two-day census. Three hundred and eighty-six or almost 82% were adults, of which 115 or almost 30% were 'non-sexed'. Two hundred and seventeen or 80% of the 271 sexed adults were females and 85 or 39% of these were reported to be accompanied by young. This is one young for every 2.6 sexed females. Thirteen of the sanctuary's 33 compartments reported no wild buffalo and five reported only solitary males. - Three hundred and thirty-seven or almost 71% of the 471 total were observed in the Baguri Block. Others were undoubtedly missed during the census and there are probably at least 550 wild buffalo in Kaziranga.

Considering the predominance of females in the sexed adult population observed during the census (four adult females per adult male) and the relatively high reproductive potential of this species (one young per adult female per year or at most every two years), it appears that the sanctuary's buffalo population could easily become too numerous. Both wild buffalo and elephant are little endangered by the annual floods covering the sanctuary and, except for small young, are relatively immune to the effects of natural predation. Another factor to be considered is the relatively large number of semi-wild buffalo in the sanctuary. Over 2000 head of domestic buffalo are presently grazed in Kaziranga. Graziers are unable to keep domestic males with their herds, because they are usually killed by wild males. Therefore, domestic females are practically always served by wild males and the resulting cross-breed young males are sometimes permitted to become feral. This problem could be eliminated with the elimination of domestic livestock grazing inside the sanctuary. However, when discussing the possibilities of the wild buffalo becoming too numerous, Mr. Gee informed me that the sanctuary's population has not increased during recent years, but has actually appeared to decrease. Whether or not this can be attributed to diseases contacted from domestic animals or other factors should be thoroughly investigated,

Swamp Deer

The slender and graceful swamp deer of Kaziranga are usually seen in groups or herds on the short andropogonous grasslands surrounding the *bils*. Predominantly female with young or male groups were generally encountered during the census. According to the Forest Department staff, the breeding season of the sanctuary's swamp deer is between November and December. Groups or harems of females are then observed with adult males. Brander (1923) stated that the rut is ill-defined, but that mating in central India is mostly from mid-December to mid-January. The gestation period was observed in the London Zoo to be 240 to 250 days or approximately 8·2 months (Zuckerman 1952-53). The fawning period in Kaziranga is reported to start in the latter part of May or first of June. Prior to and during the census, very few small young were observed and most young were approaching yearling size. The antlers of all males that I observed were in velvet and most were in the early stages of development. This coincides with the reported November-December rut, as well as the hardening of the antlers by late October, and the shedding of the antlers in late December or early January.

A total of 213 swamp deer were tallied during the two-day census. Two-hundred and seven or 97% were adults, of which 141 or 68% were 'non-sexed'. Forty-nine or 74% of the 66 sexed adults were females and only six or 10% were reported to be accompanied by small young. Eighteen of the sanctuary's 33 compartments reported no swamp deer and two reported only a single female each. None were reported in the entire Tamulipathar Block and only a single female in the Bhawani Block. Because of the large proportion of 'non-sexed' adults and the fact that all except small young were classified as adults, it is difficult to derive any conclusions from the census data as to the reproductive status of the sanctuary's swamp deer population.

I observed 152 swamp deer between March 3 and 18 : 21 'non-sexed' adults, 45 adult males, 57 adult females, and 29 young (including those approaching yearling size). Fifty-six% of the sexed adults were females and almost 51% were accompanied by young. Dr. George Schaller classified a total of 108 swamp deer in May 1965. Fifty-three% of his sexed adults were females and approximately 33% were accompanied by young. Both of our observations were apparently prior to the fawning season. Considering these factors, Kaziranga's swamp deer population appears to be thriving. Because of the open areas which they generally frequent, swamp deer are readily observed in Kaziranga. However, some were undoubtedly missed during the census and there are probably at least 250 head in the sanctuary.

Sambar

Sambar are usually shy and somewhat solitary in nature and the forested areas in which they are generally encountered makes it difficult to census their numbers accurately. This deer has a wide distribution in southern Asia and its reproductive behaviour apparently varies with the region. Blanford (1888-91) reported that in peninsular India the rut period is from October to November, but Phillips (1927-28) stated that in the lowlands of Ceylon there is no definite season. Cahalane (1939) claims that in its 'native habitat' the fawning season for the sambar is usually May or early June and Lydekker (1924) stated that the gestation period is about eight months. Information concerning antler development or size of the young was not recorded during the census. However, the sanctuary staff claimed that adult males in the sanctuary have hard antlers in October, the rut period occurs in November and December, and the antlers are shed in late December. It was also claimed that the main fawning period takes place between May and June, which is too early to coincide with a November-December rut period coupled with an eight month gestation period. I saw only two sambar during my observations in Kaziranga, a female and an adult male with hard antlers.

A total of 120 sambar were tallied during the two-day census. One-hundred or 83% were adults, of which only 6 were 'non-sexed'. Sixty-one or almost 65% of the 94 sexed adults were females and 20 or almost 33% were accompanied by young. It was surprising to see such a relatively high count during the census, but 19 of the sanctuary's 33 compartments reported no sambar, 6 reported only one each, and 5 reported two animals each. Three compartments (compartment 5 of the Baguri Block with 38, compartment 2 of the Bhawani Block with 60, and compartment 4 of the Haldhibari Block with 5) reported 103 or 72% of the total count of 120 sambar. Only one sambar each was reported for the Kaziranga, Baralimora, and Panbari Blocks, two from the Charigharia Block, and three from the Tamulipathar Block. Checking with the Forest Department staff, it was found that the three principal compartments were noted for their high densities of sambar. Also, other reliable sources have claimed that they have observed exceptionally high numbers of sambar in these areas and that, although this species is usually relatively solitary, they were often seen in groups of over fifteen. Therefore, the census reports are apparently reliable. Many sambar were also undoubtedly missed during the census and there are probably at least 300 in the sanctuary.

Hog Deer

The relatively small and gregarious hog deer is by far the most common ungulate in Kaziranga. Groups of these deer running through the

dense grasslands are very difficult to count, and accurate age composition and sex ratio data are even more difficult to collect. Therefore, no attempt was made during the census to record more than a total count.

A total of 1311 hog deer were tallied during the two-day census. This is probably only a small proportion of the sanctuary's population, which probably numbers between four and five thousand. Dr. George Schaller classified 290 hog deer in May 1965. Approximately 240 or 83% were adults, of which 118 or 49% were females. Forty-eight or 17% of the females were accompanied by young. He also observed that approximately 15% of the total population consisted of yearlings (between one and two years old). Although I observed over 500 hog deer prior to the census, I only classified groups totalling 128 : 53 adult males, 59 adult females, and 16 young. Fifty-three% of the adults were females and 27% of these were accompanied by young.

The sanctuary staff appeared to be indefinite as to when the majority of hog deer males have hard antlers, when the main rut occurs, and when the males shed their antlers. However, the majority of the males had antlers in velvet (later stages of development) at the time of the census. A relatively large number also had hard antlers and a few had recently shed their antlers. It was claimed that the main fawning season begins between May and June, but it appears that fawning is over an extended period of time or that there are more than one peak period. Hog deer are well distributed throughout Kaziranga and only two of the sanctuary's 33 compartments (1 and 4 in the Baralimora Block) failed to report them.

Barking Deer

Barking deer are solitary forest dwellers. They never form large groups or herds, although they are occasionally encountered in family groups of two or three. The dense forest undergrowth which they normally inhabit and their solitary and shy disposition make it extremely difficult to determine their numbers accurately. Little appears to be known about their reproductive physiology in Kaziranga, other than it is claimed that all of the males have hard antlers in July. Although they were reported to be relatively abundant in some of the sanctuary's forests, I observed only two and am, therefore, unable to add any additional information concerning this species.

A total of 29 barking deer were tallied during the two-day census. Sex and age ratio data was not recorded. However, all were observed in the forested areas of three of the sanctuary's eight blocks, Baguri, Haldhibari, and Panbari. This is probably only a small proportion of the total population and there are undoubtedly 100 or more in the sanctuary.

Wild Pig

Wild pig are relatively common in many parts of Kaziranga, particularly in the marshy grasslands. Except for solitary males, they are usually encountered in family groups or sounders. The dense grass which they generally frequent and their practice of breaking for cover when closely approached make it difficult to count their numbers accurately or to determine the sex and age composition for groups observed. Although they are reported not to have any definite breeding season, I did not see any small young among the 118 pigs which I observed prior to the census. Half-grown young were, however, frequently seen.

A total of 155 wild pigs were tallied during the two-day census. One-hundred and thirty-seven or 88% were recorded as adults, of which 72 or almost 52% were 'non-sexed'. Twenty-seven or 43% of the sexed adults were females and they were accompanied by 20 young. Eleven of the sanctuary's 33 compartments, including the entire Bhawani Block, reported no pig. Only a small proportion of the wild pig population was observed during the census and an estimate of five to six hundred for the sanctuary would not be unreasonable.

Other Animals

Other animals recorded during the census included : gaur or Indian 'bison', tiger, leopard, bear, otter, water monitor, and python.

Gaur—are not uncommon in the Mikir Hills to the south, but they have rarely been seen in Kaziranga. There is one unofficial report of a herd of nine of these impressive bovines and several skulls of adult males have been recovered from the sanctuary. These are presently on display at the Range Officer's office in Kohora. However, many men on the staff have never observed gaur in this area. A single solitary male was observed in the Charigharia Block during the census and probably fewer than 20 inhabit the sanctuary.

Tiger—have been infrequently observed in Kaziranga. However, based upon the relatively few tiger signs observed, they appear to be quite rare in the sanctuary. This is rather surprising considering the abundance of prey species, particularly hog deer and wild pig. Two were observed during the census, one each in the Haldhibari and Bhawani Blocks. A courting pair was also observed during my June visit at Mihi Mukh. Probably fewer than 20 exist in the sanctuary.

Leopard—have been seen in Kaziranga on only a few occasions. Some members of the Forest Department who are intimately acquainted with the sanctuary have never observed leopard nor their sign in the sanctuary. Except for a leopard skull, I likewise observed no sign of leopard. However, several visitors reported seeing a leopard climb a tree along the road leading to Arimora just a few days prior to the census.

A leopard was also reported in the Kaziranga Block during the census. Although their presence has been definitely established, they are still apparently rare and it is doubtful that more than a dozen reside in the sanctuary.

Bear—appear to be relatively common in Kaziranga. Although they are generally noted for being nocturnal in habits, they are quite frequently observed in many parts of the sanctuary. I saw what appeared to be an adult sloth bear in the Baguri Block on March 6. Many bear signs (i.e. scratches on trees and destroyed termite hills) were particularly evident in the forested areas of this block. Besides official sightings of sloth and Himalayan black bear, visitors have also reported seeing bear with a yellow 'U' on their chest, which may well be the Malayan sun bear. Two bears were observed during the census, one each in the Baguri and Kaziranga Blocks. Although difficult to estimate, there are probably at least 30 in the sanctuary.

Otter—are frequently seen along the sanctuary's numerous streams and in many of its *bils*. Fishing is prohibited inside Kaziranga and as a result many of the streams and *bils* are literally teeming with fish. The abundance of food and suitable habitat probably account for the relatively large numbers of this interesting mammal, which has become all too rare in many parts of India. Prior to the census I observed more than 50 otter, including numerous family groups. A total of 29 were reported during the census from five of the sanctuary's eight blocks. There are probably several hundred otter in the sanctuary.

Water Monitor—Water monitor (*Varanus* sp.) are fairly common in some of the marshy areas or along some of the sanctuary's waterways. These reptiles often attain a total length of over six feet. Their large size and striking colouration, consisting of a dark background splotched with bright yellow, make an impressive sight. I observed two prior to the census and two were also reported during the census. A relatively accurate estimate of their total numbers in the sanctuary would be very difficult to ascertain.

Indian Python—are one of the various species of snakes which are not too uncommon in many parts of Kaziranga. However, due to the annual burning of much of the grassland, their numbers are probably held somewhat in check. I observed a python in the Baguri Block prior to the census. It was approximately 10 feet long and had recently swallowed a meal. Another python was also observed during the census in the Kaziranga Block. A cobra was seen near Baguri during my June visit. No attempt will even be made to estimate the numbers of python or other snakes in the sanctuary.

Time of Observation

It is generally assumed by many people that most wild animals are

more readily observed during the morning rather than in the afternoon or evening. However, my observations prior to the Kaziranga census indicated that this was not true for many mammals in the sanctuary during this time of the year. For example, on March 5, I spent three and three-fourths hours (06.15 to 10.00) in the morning and about three and three-fourths hours (14.15 to 18.10) in the afternoon on elephant back making a somewhat circular transect in the Baguri Block, visiting as many *bils* as possible. Besides other mammals, I observed 14 rhino and 34 buffalo during the morning and 17 rhino and 73 buffalo during the afternoon. The following day I followed the same route, but in reverse order. This time I spent four and one-half hours (06.45 to 11.15) in the morning and about four hours (14.00 to 18.10) in the afternoon on elephant back. Again fewer animals were observed during the morning than during the afternoon: 11 rhino and 55 buffalo as compared to 23 rhino and 88 buffalo. During an additional eight days spent on elephant back in other parts of the sanctuary, the same trend generally held true and I usually observed more animals in the afternoon than in the morning. Therefore, during the two-day census the counts were tabulated on a morning versus afternoon basis. Due to a number of factors, the census parties worked a total of 158 hours during the morning and only 96 hours during the afternoon. However, comparing the numbers of the common mammal species observed per hour for each period, the data again indicates that the afternoon was best to observe most animals in the sanctuary during this season (see Table 4).

TABLE 4

COMMON LARGE MAMMALS OBSERVED DURING THE MORNING AS COMPARED TO THE AFTERNOON DURING THE 1966 WILD LIFE CENSUS OF THE KAZIRANGA WILD LIFE SANCTUARY, ASSAM

Kind of Animal	Average Number Per Census Hour		Total Number Observed	
	Morning	Afternoon	Morning (158 hrs.)	Afternoon (96 hrs.)
Rhino ..	1.3	1.6	207	159
Elephant ..	0.4	2.9	69	280
Buffalo ..	1.2	2.9	194	277
Swamp Deer ..	0.9	0.8	139	74
Sambar ..	0.1	1.1	14	106
Hog Deer ..	5.1	6.1	724	587
Wild Pig ..	0.7	0.4	112	43

Other Factors

It will be noted that those blocks in which livestock grazing is permitted or that are most distant from the cultivated areas along the Grand Trunk Road had lower densities of wild animals, particularly rhino,

than did the other blocks. In the case of areas grazed by livestock, this can probably be attributed to a lack of suitable forage and perhaps to disturbances and other factors associated with domestic livestock grazing. However, in the case of the more distant areas that are not grazed by domestic livestock to any appreciable extent, it is difficult to pinpoint the exact reasons. The habitat may be less desirable or, perhaps, particularly in the case of rhino, poaching may be an important factor. Also, it may be that the cultivated areas along the southern boundary serve as an attraction to wild animals, such as the rhino, and that they tend to congregate in the adjoining parts of the sanctuary so as to have ready access to the cultivation during the crop seasons. Crop depredation, particularly by rhino, is a serious problem in this area and one man was recently killed by a rhino while trying to protect his crops. Wild buffalo, particularly solitary bulls joining herds of domestic cows, are also a problem and a number of people in the vicinity of Kaziranga have been injured by them.

V. CONSERVATION PROBLEMS

Livestock

It was realized when Kaziranga was first recognized as a sanctuary that domestic livestock grazing is not desirable in an area dedicated to the preservation of wild life. However, grazing had previously been permitted when Kaziranga was recognized as a Reserved Forest. Therefore, graziers had established prior rights. Also, due to the prevalence of rhino poaching and a lack of sufficient number of Forest Department personnel to patrol the sanctuary and to protect the wild life effectively, the then Chief Conservator of Forests (Mr. A. J. W. Milroy) felt that the establishment of *khutis* along the bank of the Brahmaputra would help to deter poachers from the sanctuary. Poachers were generally known to enter this area from the Brahmaputra River. Therefore, an agreement was made between the Forest Department and the professional graziers whereby the graziers would immediately report to the Forest Department anyone whom they observed entering the sanctuary through their *khutis* or buffalo camps along the banks of the river. Although such information has oftentimes been of value, it is not known whether or not this service is presently of sufficient value to offset the deleterious effects of livestock grazing. Grazing fees are presently paid to the Forest Department by 39 professional graziers for rights to graze over 1500 head of adult buffalo in the sanctuary areas bordering the Brahmaputra River. Fees are not charged for animals under two years old and they are not included in the official total. Eight of these professional graziers also pay fees to graze almost 300 head of adult cattle in this area. Therefore, the actual number of domestic animals, including animals under

two years of age, presently grazing in the part of the sanctuary adjoining the Brahmaputra probably exceeds 3000 head.

Prior to 1950 domestic livestock grazing in Kaziranga was confined to the *khuti* areas along the Brahmaputra. However, due to political expediency, livestock grazing was then initiated in the Kaziranga Block. The Government then gave grazing rights inside the sanctuary to villagers living along the boundaries of Kaziranga. This initially involved the encroachment of domestic livestock upon a one-square-mile area, but has since been extended to a two-square-mile area. This grazing area is not demarcated and the cancerous disease of overgrazing by domestic livestock is slowly eating its way deeper and deeper into the sanctuary. Presently 10 professional graziers and 56 villagers have permits to graze over 450 head of adult buffalo in this area. Although cattle are supposedly excluded, I counted over 100 head of cattle during my brief visit to the Kaziranga Block on March 14. I also observed over 30 head of domestic buffalo near Charigharia on March 8, which is in the heart of the sanctuary. In addition, livestock belonging to villagers living along the sanctuary's boundaries almost invariably graze along the edges of the sanctuary. Therefore, in addition to illegal grazing, approximately four to five thousand head of livestock are presently grazed inside Kaziranga.

When domestic livestock and wild life are present in the same area there is direct competition for forage, and wild life is usually the first to suffer and become eliminated. This was dramatically demonstrated by the results of the Kaziranga wild life census. Areas inhabited by domestic livestock contained relatively few, if any, wild ungulates. This was particularly true in the case of rhino. For example, prior to the advent of grazing in 1950, compartment 4 in the Kaziranga Block was noted as one of the sanctuary's outstanding rhino areas. However, only eight rhino were reported during the census for the entire compartment. Further, none were observed in the two-square-mile area grazed by domestic livestock.

The presence of domestic livestock also presents the possibility of introducing diseases and parasites which may prove fatal to wild life populations. There is the possibility that the sanctuary's wild buffalo population is presently being controlled by parasites or diseases. An example which may be attributed to the drastic effects of disease upon wild animal populations is the case of the near extermination of the swamp deer in Kanha National Park, Madhya Pradesh.

The grazing of domestic livestock requires the presence of herders and other people. In addition to the domestic animals, these also create disturbances which many wild animals cannot tolerate. As a result, their numbers will decrease or the species may eventually disappear altogether from an area. The high incidence of mortality due

to injuries sustained in fighting among rhino in the Laokhowa Reserve may be the result of too many disturbances. Females with recently born young will often abandon them if they are frequently disturbed or if their young are touched by humans.

Erosion

Annual flooding of Kaziranga is undoubtedly essential for the maintenance of optimum habitat for wild animals such as rhino, wild buffalo, and so forth. However, the loss by erosion of relatively large portions of the sanctuary bordering the Brahmaputra is a major problem. Although some areas on the western end of the sanctuary are being built up by deposition, erosion from the eastern end is taking place at a more accelerated rate. It is presently estimated that about 15-square-miles of Kaziranga have been lost to erosion since 1950.

The Embankment and Drainage Department (E. & D. Dept.) has proposed that a *bund* for flood control be constructed along the Brahmaputra in the north-eastern part of Kaziranga. Preliminary surveys were initiated in 1965, but were discontinued upon the insistence of the Forest Department. The E. & D. Dept. maintains that the construction of a *bund* is essential for flood control. On the other hand, the Forest Department claims that annual flooding of the sanctuary is essential for the welfare of the wild life and that the consequences of flood control would be worse than the losses to erosion. Presently this issue is a controversy between the two departments.

Some experimental plantings of different grasses and shrubs for the control of erosion have been made in one area inside the sanctuary. Although the value of such plantings has not yet been thoroughly demonstrated, it appears that such methods of erosion control should be investigated. It also appears that overgrazing by domestic livestock along the banks of the river may be a contributing factor in the acceleration of erosion. As previously mentioned, without the annual floods temporarily clearing the water areas inside the sanctuary, they would shortly become a solid mass of water hyacinth. In addition, the elimination of annual flooding would change the ecology of the entire sanctuary. There is also the danger that if a *bund* was constructed it may be breached by the high flood waters of the Brahmaputra, which would then result in the devastation of the sanctuary and its wild life.

It is my opinion that the Forest Department is right in not permitting the construction of a *bund* in this area. However, measures should be taken to check the sanctuary's losses to erosion. These would probably include the removal of domestic livestock grazing along the banks of the Brahmaputra and extensive plantings in the affected areas. *Chapories* formed along the southern bank of the river at the western end of Kaziranga should also be considered as a part of the sanctuary.

Exploitation

Exploitation of Kaziranga's natural resources, with the exception of domestic livestock grazing, was prohibited until this year. However, in February 1966 the Government of Assam passed an order allowing the local people to collect thatch from the sanctuary for domestic use. It is argued by some that such natural resources should be exploited, rather than 'wasted' or annually burned. However, if such exploitations are permitted inside the sanctuary, where is the line to be drawn? Numerous examples could be given of how the wild life in many of India's other sanctuaries has been completely devastated by the ever-increasing demands of the local people for the exploitation of their natural resources. The results in many cases has been the conversion of once beautiful and choice areas, with great economic potential, into little more than deserts which are of little value to anyone.

Education

Without the co-operation of the inhabitants living and working in the vicinity of Kaziranga, it is difficult, if not almost impossible, to administer efficiently or to protect fully the sanctuary and its wild life. The importance of publicity and education cannot be over-estimated. The local villagers and particularly the local members of the legislature must be convinced of the long-term economic advantages of wild life resources. It is essential that the right kind of publicity and education be done so that these people will be emissaries of nature conservation, rather than advocates for immediate short-term exploitation of the sanctuary's natural resources. Perhaps the local people could most easily be convinced of the value of Kaziranga by some concrete and useful project, such as the construction of a school with funds proclaimed as having come from a part of the revenue earned by the sanctuary's wild life.

Kaziranga, in addition to already being the most outstanding wild life sanctuary in southern Asia, has the potential of becoming one of India's greatest sources of much needed foreign exchange. This potential will probably never be realized if political expediency is permitted to dominate the sanctuary's practices and policies. The question should be settled once and for all. Is Kaziranga going to be permitted to realize its potential long-term economic advantages based upon the conservation of its wild life resources? Or are ever increasing demands for immediate short-term exploitation of its natural resources going to be met? Both cannot be realized simultaneously! Visitors to Kaziranga are not willing to pay travel and accommodation expenses for the opportunity of seeing domestic livestock or grass cutters inside the sanctuary. Now is the time to make the decision. If those in responsible positions are wise enough to choose the better course of action, they will probably initiate the necessary legislation to constitute Kaziranga legally as an inviolate

national park—dedicated to the preservation of a part of India's great wild life heritage and above the demands of exploitation by the local people and politicians. The status of a national park would also give added prestige and publicity to this outstanding wild life area.

Poaching and Illegal Fishing

Although poaching, particularly of rhino, is one of the problems confronting Kaziranga, it does not appear to have attained the proportions that some recent newspaper articles have indicated. Poaching also appears to be restricted primarily to the north-eastern part of the sanctuary, particularly in the areas most distant from the office at Kohora and specifically in the vicinity of Dhansiri Mukh. Poaching appears almost non-existent in the areas frequented by visitors, such as near Mihi Mukh and the Baguri Block.

The common method for poaching rhino in this area is the digging of pits along their trails. In this manner a small band of poachers has a very good chance of obtaining a number of rhino with relatively little danger of being apprehended. Rhino horn, most of which eventually reaches China where it is thought to have potent aphrodisiac qualities, is said to sell for as much as Rs. 6000 per kg. on the black market.

Professional fishermen also enter Kaziranga with their boats and nets during the flood season or by means of its many streams. They often hide their equipment in or near the numerous *bils* and return at irregular intervals to exploit the sanctuary's fishery resources illegally. It is claimed that a single party can remove as much as Rs. 2000 of fish from the sanctuary per day. We found and destroyed eight dug-outs, most of which had been hidden by sinking them along the edges of *bils*. However, due primarily to the dense cover, it is extremely difficult to apprehend the culprits and even more difficult to take them into custody.

It is not economically feasible to employ sufficient personnel to maintain a continual vigilance over the entire sanctuary. Neither should the sanctuary be 'honey-combed' with numerous roads for patrolling purposes. However, there are a number of preventive measures which could be employed.

Both poachers and fishermen generally operate inside Kaziranga in armed bands. Therefore, a single or even several Wild Life Guards are practically helpless or take a great risk in attempting to take them into custody. In order to operate efficiently against such groups, patrol units of at least six armed men are needed. Also, the most efficient or practically the only means of travel in much of the sanctuary is by elephant back. Anti-Poaching Squads or Patrol Units consisting of at least two elephants, their mahouts and grass cutters, and armed guards supervised by a Deputy Ranger would probably be the best and most economical means of combating such illegal activities. Such units should be supplied with

tents and other equipment so that they could remain in the field indefinitely. Portable walkie-talkie sets would also be valuable in co-ordinating the activities of such groups and providing a means of communication with the rest of the sanctuary. These units would be completely mobile and their mere presence should act as a deterrent to poachers or other law-breakers. These units could also be shifted to patrol boats during the monsoon or flood seasons.

There is a dire need for a means of communication inside the sanctuary. Travel at best is slow and difficult. Presently it often takes the better part of a day for men stationed at the various guard posts in the sanctuary to send a report to the office at Kohora or vice versa. Under such conditions little can be done to co-ordinate activities in situations such as the apprehension of law-breakers. Either a telephone or radio communications system should be installed at least between all beats and the office at Kohora. Telephone communication between Kohora and Jorhat, Gauhati and Shillong should also be improved, both for official use and for use by visitors to Kaziranga.

Fair-weather roads presently connect Kohora and Baguri with the Forest Rest House at Arimora. However, travel on them is slow and rough and they are jeepable only during a part of the year. Although it is probably advisable to keep road construction inside the sanctuary to a minimum, it is suggested that the present roads be improved and maintained in good condition and that an east-west road be constructed along the south bank of the Diphlu River connecting the Kohora and Baguri roads. Vehicular traffic would thus be improved and the movement of men and supplies inside the sanctuary would be greatly facilitated.

Besides a lack of equipment such as arms and ammunition, there is presently little incentive for Wild Life Guards to apprehend those whom they encounter violating the law. They are subject to great personal risks when attempting to apprehend violators, but gain little, if anything, by taking them into custody. They receive the same pay, which in most cases appears to be inadequate, whether they fully meet their obligations as guardians of the public domain or whether they do very little in this regard. Men are rarely rewarded for work well done, while, on the other hand, they are rarely dismissed for not fulfilling their obligations. A system of rewards for acts of bravery and devotion to duty would serve as an added incentive to apprehend poachers. And, a more effective system of punishment should be established so that men who do not meet their obligations can be dealt with effectively.

The presence of visitors in an area acts as a deterrent to poachers and other law-breakers. Therefore, visitors to Kaziranga should be encouraged to visit as much of the sanctuary as possible. This can be done by the provision of accommodations and other facilities in as many parts of the sanctuary as possible. For example, if in addition to

Kohora, accommodations and elephants were furnished for visitors at Arimora, Baguri, and near Kaziranga, the greater part of the sanctuary would probably be immune to illegal activities such as poaching.

Administration

The Forest Department officers in charge of the Kaziranga Wild Life Sanctuary have been trained in forestry. Very few have received training in wild life management. Considering this, the supervision and administration of Kaziranga has been especially commendable. This may in part be attributed to the fact that many members of the staff have a personal interest in wild life and have taken it upon themselves to learn some of the basic concepts of wild life management. However, like forestry, wild life management is a technical profession and a fulltime job.

It has been wisely proposed in the Forest Department's present five-year working plan that the cadre for the protection and preservation of the State's wild life should be separated. A Wild Life Division within the Forest Department has worked well in other states such as Uttar Pradesh. Such a division would help to attract qualified men and would provide a means whereby personnel interested in this specialized type of work could be better trained. It would also make for better administration of the State's various wild life areas and provide opportunities for promotion in this field. Presently when a man is promoted for outstanding work in a sanctuary, such as Kaziranga, it almost invariably means that he must be transferred back to a regular Forest Department position.

VI. RECOMMENDATIONS

The following recommendations are made :

1. That Kaziranga be legally constituted and officially recognized as a National Park.
2. That the exploitation of Kaziranga's natural resources, including the cutting of reeds and thatch, felling of trees, fishing, and shooting, be perpetually prohibited and the rules and regulations prohibiting their exploitation be strictly enforced.
3. That all domestic livestock grazing be prohibited inside the sanctuary. If this is not presently possible, only established *khutis* along the bank of the Brahmaputra River in the northern part of the sanctuary should be allowed to remain and then the numbers of domestic grazing animals should be progressively reduced and strictly controlled. Livestock grazing in the Kaziranga Block should be stopped immediately.
4. That all areas south of the Grand Trunk Road into which rhino and other animals move during the flood season be declared as a Buffer Zone and be demarcated as such.

5. That the portions of the Mikir Hills south of Kaziranga into which elephant and other animals migrate be constituted as a Reserved Forest.

6. That, because of administrative and political difficulties involved, the actual area of Kaziranga not be added to, but that all *chapories* formed along the south bank of the Brahmaputra River, either by erosion or by deposition, be considered as a part of Kaziranga.

7. That the construction of roads and facilities within the sanctuary proper be maintained at a minimum. However, that the present roads be improved and that an east-west road connecting the present Baguri and Arimora roads be constructed along the south bank of the Diphlu River.

8. That a telephone or radio communication system be installed between each of the beats in the sanctuary and the office in Kohora. Telephone connections between Kohora and Jorhat, Gauhati and Shillong should also be improved.

9. That mobile patrol units (consisting of mahouts, elephants, and armed guards with portable walkie-talkie sets) be detailed to patrol regularly the entire sanctuary to minimise illegal activities, particularly the poaching of rhino.

10. That a separate Wild Life Staff or Division be established within the Forest Department on a State-wide basis. This would permit the selection of men interested in and qualified for positions in the State's wild life areas and would also provide opportunities for promotion for outstanding work in this field.

11. That a system of rewards and punishments be established to encourage Forest Department personnel to better meet their obligations concerning the preservation and protection of wild life. Rewards for acts of bravery and devotion to duty, as well as a portion of all fines collected, should be given to the Forest Department personnel concerned. Likewise, greater emphasis should be placed on meting out suitable punishment to those that neglect or violate their obligations as guardians of their nation's wild life.

12. That an *esprit de corps* be fostered in the Wild Life Staff by such means as : the provision of uniforms and appropriate badges for all personnel, the payment of salaries appropriate to the obligations and duties entailed, the provision of opportunities for advancement in all positions, the provision of adequate living accommodations, and a system of rewards and punishments as recommended in No. 11.

13. That additional facilities for visitors be provided. First class accommodations at Kohora need to be improved, and additional facilities are also needed during the December-April visitor season and for groups on scheduled tours. These could most economically be provided by the construction of dormitory facilities. Tourist Lodges with modern

conveniences, adequate staff, elephants, etc., are also needed at Baguri and at the eastern end of the sanctuary.

14. That transportation be provided for visitors from Jorhat to Kohora and within the sanctuary. The possibilities of constructing an airfield in the vicinity of Kaziranga should also be thoroughly investigated.

15. That private enterprise, under the direct supervision of the Forest Department, be encouraged in the construction, maintenance, and operation of the sanctuary's visitor facilities, such as Tourist Lodges, catering, transportation, boat excursions, souvenir shops, and so forth.

16. That a programme of education and publicity be undertaken both to help people in the vicinity of Kaziranga become aware of the importance and value of this area and to attract visitors.

17. That information concerning the sanctuary (i.e. pamphlets, folders, postcards, etc.) should be made available through the Department of Tourism and recognized tourist agencies.

18. That wild life enumerations, similar to this year's, be conducted on an annual basis. However, that the most efficient and economical means of conducting such surveys also be thoroughly investigated.

19. That scientific studies of the sanctuary's wild life, particularly of the rhino, be encouraged by qualified personnel and that facilities (i.e. accommodation, elephants, etc.) be provided whenever possible.

20. That wild life observations both by visitors and by the sanctuary staff be kept in a permanent record in the sanctuary. Also, that check-lists of the sanctuary's birds, mammals, and reptiles be compiled and provided for visitors.

21. That aerial photographs be obtained of the sanctuary and that accurate maps depicting the vegetation types, *bils*, etc., of Kaziranga be made from them.

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The Forest Department of Assam and its staff are to be commended for the fine work they have done and are doing to help preserve wild